THE RELATIONS OF MIND AND MATTER.

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IV. The Instrumentality of the Brain.

WE have, in the preceding sections, reached several conclusions as to the character, development and mode of operation of the nervous organism. We have next to consider this organism in its relation to the development of the mind. This is undoubtedly the most difficult of the whole broad scope of problems to which science has addressed itself. Much has been written upon it, but we can scarcely say much that is satisfactory. It remains yet in great measure an open question, though a far narrower one than of old. Science has strongly attacked the outworks, if not the citadel of the problem, and has effectually dispersed the cloud of immaterial existences about which the thoughts of men so long hovered. It is becoming clearly evident that all existence is based upon substance. It may not be that species of substance which we call matter. For all we know there may be many species of substance. Yet there is no resting-point between something and nothing, and immateriality sinks into the category of nothingness.

But we are able to bring the conditions of the mind much nearer to the ordinary conditions of the material universe than this. The old idea that the soul is brought full fledged from some distant limbo of souls, and implanted in the infantile organism, might serve for the philosophers of a mediæval dreamland, but can hardly be sustained in this wide-awake age. To us the germ of the mental organism forms part of the physical germ, and the whole development of the mind takes place through the influences acting upon the body. It is well known that the degree of the mental development is in close accordance with the variety and quantity of these external influences. If the body be closed against their entrance, through loss of the organs of the higher senses, the mind remains undeveloped. If all the senses were shut off and no external influence permitted to reach the germ of the mind, it must continue in the germinal state. In like manner if the senses be active, but the brain, the inner organ of the mind, be inactive or abnormal in condition, the mental development is similarly checked. All this needs no argument. Every one

must admit that the development of the mind takes place through the agency of external energies transmitted by the nervous mechanism.

But these energies are entirely motor. They are either radiant vibrations emanating from some distant substance, or the motions of molecules impressed upon the body through direct contact. Each of them has its special character, but they are all motions. In their transmission inward over the nerve fibers they continue to be motor agencies. They are now some mode of radiant energy. Those that pass through the ganglia and reach the muscles, prove their motor character by disturbing the motor relations of the muscle cells. Those that are retained in the ganglia, and yield other effects, must do so as motor agencies. It is simply impossible that motion can become anything else. Nor can it exist independent of substance. Nor can it cease to exist. Every quantity of motion must of absolute necessity continue to exist as the same quantity of motion. It cannot lose or gain quantity, or change into some condition that is non-motion. Nor can it exist as an immaterial condition. It is indissolubly wedded to substance.

These conclusions can scarcely be questioned by any scientist, yet they lead to certain important inferences. If the development of the mind takes place solely through the influence of special motions, conveyed to it over the channel of the nerves, then the mind must necessarily be based in substance, and its energies must necessarily be motor. The idea that an immateriality can be organized by motor agencies is a mere metaphysical phantasm.

But though a definite quantity of motion cannot lose or gain, its action upon matter may be almost infinitely varied. It may separate and become widely diffused, or it may become definitely fixed in a certain aggregate of matter. The organization of matter takes place solely through the influences of its inherent motions. The concentration of a crystal may be due to attraction, but its peculiar characteristics are undoubtedly due to the special motions of its particles. And an Amœba is superior in organization to a crystal solely through the vastly greater complexity and intricacy of the motions which affect its particles. In all these cases of aggregation the attractive agency seems to be single and unvarying in character. Its full effect is resisted by the

motion of the constituent particles, and with every variation in the vigor or complexity of these motions some variation in the volume, form or rigidity of the mass takes place. The reduced rigidity and varied constitution of organic cells is primarily due to the great absorption of heat or motor energy in the formation of their chemical molecules, and the variety of such molecules which enters into their constitution.

This consideration of the relations of matter and motion leads to a second. Motion may affect matter in either a general or a special mode. In the former case it tends to disorganize, in the latter to organize matter. Heat motion is a disorganizing influence. It constantly tends towards the disaggregation of matter. Electricity yields results partly of disintegration, partly of integration. Magnetism is a more specialized motor agency, and its effects tend to integration. The motor energies which enter into chemical phenomena are yet more varied and specialized, and tend strictly towards material organization. Thus the disorganization and organization of matter seem alike due to motor agencies. In the case of all organization the attractive affinities of chemical particles enter as an essential element. Motion, of whatever kind, may oppose these affinities, but it is quite possible for a definite harmony to exist between these two agencies. For instance, the solar system is a definite organism, due to the harmonized relations of its motions with its gravitative attractions. The same is the case with the earth as a whole, and with every crystal upon the earth. In the case of the solar system the disrupting activity of motion is overcome by its being forced into closed curves of rotation, yielding a fixed balance of energy between the two opposing forces. Something similar may exist in all organized masses. Every mass of fixed organization, whether it be earth, crystal, organic cell or animal body is subject to the opposite influences above named, those of attraction and motion, and its fixity indicates that a definite balance exists between these influences. Motion, therefore, may be said to be organizing when, by moving in closed curves or in other special modes, it becomes in harmony with attraction, the degree of concentration of matter depending on the comparative vigor of the two opposing forces.

All this may seem to have no relation to the problem of the development of the mind. Yet it is evident that motion is the

agent directly concerned in this development, and we can conceive of but one result of the agency of motion, that of change in the space relations of matter. The motion which enters the cerebral ganglion, and is retained there, cannot cease to exist. One of two things must happen. It may flow into the surrounding matter as heat, or in some other general and dissipating condition. Or it may become an organizing agent, and enter into some substance as a permanent factor. It may produce a mental compound of substance analogous to the inorganic crystal, and like the latter unchanging in form and in its internal conditions. The disorganizing energies of nature act upon the crystal. Heat and electricity pass through it but do not disintegrate it unless they become of excessive vigor. The same may be the case with the mental organism. This much we know, that the special motor energies which enter the body and are conveyed to the cerebrum produce those conditions which we call memories, and which are permanent and unchanging. If these are motor conditions they must be motions of organization, influences which partly overcome but which fall into harmonious relations with the force of attraction and condensation. And it follows as a corollary that the development of the mental organism from its germ to its highest unfoldment takes place through a continued succession of these organizing motor influences. The intricacy of the organism steadily increases, as it is affected by motions of higher complexity, but every motor state produced is permanent. The existence of higher motor conditions does not cause obliteration of the lower ones. This is one of the marked characteristics of motion. In the circle the straight line of motion is masked, not obliterated. In the spiral the circle persists. In the spiral vortex all these inferior stages can be traced. And in the organizing motions of the mind all inferior stages persist as constituent parts of the superior stages. Consciousness may be directed to any of these motor conditions, in which case they appear as memories. But consciousness has no bearing upon their existence. They continue through life active conditions of the mind, though they may seldom or never come within the sphere of consciousness.

The preceding argument is not advanced as anything new. It is rapidly becoming a common belief with scientists that the mind has its basis in matter, and that thought is a motor affec-

tion of this matter. The belief in the material basis of mind, indeed, has become a somewhat developed idea. It has of late years grown a more and more widely accepted opinion with scientists that the brain is the organ of mind, that mental conditions are motor affections of the matter of the brain, and that they can persist only during the persistence of the brain as a functional organ, and must return into the realm of unspecialized motions on the disintegration of the brain. Before considering this question it was necessary to obtain some idea of the general principles of relation between matter and motion, and of the conditions under which alone motion could be retained in a local mass of matter in a persistent and specialized phase.

In addition to a widely entertained opinion among scientists upon this subject, several authors have made it the special theme of their works, and have brought all the conclusions of anatomical and physiological science and the principles of the correlation and conservation of force in support of their argument that the brain is the only and sufficient mental organ. Of the authors who have treated the subject from this point of view may be named Bastian and Maudsley of England, Luys of France, and Moleschott, Vogt, Büchner and Haeckel of Germany. Many other authors might be named who have dealt with it more or less directly, prominent among these being Huxley. The converse has also been taken by several authors, yet none of them can be said to have squarely met the arguments of their opponents, and the most of them have dealt with it in the old and vague metaphysical method. So far as a scientific treatment of the question goes, the brain-mind theorists seem to have the best of the argument. And yet to the present writer their arguments seem the reverse of satisfactory, and their theories to need much stronger lines of evidence before they can be made self-sustaining.

That the brain is intimately and constantly concerned in the manifestations of the mind, no one will deny. But that it is alone concerned is far from being proved. The theories proposed by the several authors are the following: Huxley declares that sensation and consciousness are in some inexplicable way caused by molecular changes in the brain. This belief is based on the facts that thought and motion seem inextricably related, that every thought is accompanied by brain waste, that heat

appears as a consequence of thought, that mental action cannot go on without a constant supply of arterial blood and must cease periodically until the brain can regain its integrity through the assimilation of nutriment, and finally that no other organ of the mind can be discovered. The latter point, however, can be left for future consideration. It will suffice here to say that if such an organ does exist, though imperceptible to the anatomist, and if the brain is its instrument of activity, the above-named cerebral phenomena would be as necessary as on the brain-mind theory.

The earliest effort to definitely deal with this question is that of Cabanis, who advanced the idea that the brain acts like a gland, and secretes thought. This idea made a decided ripple in the thinking world, though it has long since died out. Maudsley's idea is that every sensory impression upon the brain leaves behind it some modification of the nerve elements. This he considers to be the physical basis of memory. He looks on the change that takes place as a motion, which he considers analogous to the "compounds, and compounds of compounds, of vibrations in music." Other authors propound like views, and consider thought to be a persistent vibration of the nerve fibers of the brain. Luys offers the same idea in a fuller shape. He says: "I have proposed to apply the term *phosphorescence* to that curious property the nerve elements possess of remaining a longer or shorter time in the state of vibration into which they have been thrown by the arrival of external excitations; as we see phosphorescent substances illuminated by solar rays continue to shine after the source of light which has illuminated them has disappeared."

This is the present state of the brain-mind theory, as advanced by its most ardent and learned advocates. The only definite conclusion to which they can arrive is, that thought is a persistent vibration of the cerebral nerve fibers. Indeed there is no other theory open to them. The discoveries of late years hinder them from taking refuge in the powers of a brain cell of unknown organization. It has become evident that the brain cell is essentially a mass of very delicate fibrillæ which are continued through the nucleus, and in all probability are continuous with the nerve fibers. Thus we have nothing but fibers of greater or less minuteness to deal with, and it seems to follow as a necessary

consequence that if thought is nerve motion it must be some motion of elongated fibers. This motion enters the brain as a mode of vibration in these fibers, and we can conceive of its persistence in or on them in no way except as a vibration.

Yet to theorize about a persistent vibration is to theorize on the impossible, and to set aside all the results of the science of acoustics. There is no such thing in nature as a vibration persistently active in a limited region. No limited chord can vibrate unceasingly. Its vibrations must be rapidly transmitted to the surrounding material, or be converted into some other mode of motion. Otherwise the chord would have to be surrounded by a perfect vacuum, and be utterly free from friction. No such conditions exist in the brain fibrillæ. Thus a vibratory nerve current, even if transferred by induction to a closed cerebral circuit, could not possibly retain its original condition. It must make its way onward, be transferred to surrounding material, or be quickly transformed into some other mode of motion. The conditions of the mental organism require that this mode of motion shall be an organizing one, a persistent motor affection of some substance. The brain fibrillæ, which are essentially continuations of the nerve fibers, cannot constitute such a definite and self-centered organism. Neither can the cell substance surrounding these fibrillæ. It is to this granular or homogeneous protoplasm seemingly that the cerebral activity is due. The motor impulses conveyed inward by the fibers appear to instigate chemical changes in this substance precisely as they do in the muscle substance. It falls into a lower stage of integration and sets free the energies which arouse the mind to action. Thus the brain cells seem solely instruments of the mind. But for them the mind would remain dormant. They yield, under the influence of external impulses or of impulses derived from the mind itself, energies which call the mental organism into activity. But this very evident characteristic, and the constant cerebral changes which it occasions, strongly indicate that the mental organism is distinct from the cerebrum, though to all appearance very intimately connected with it.

It may seem absurd to speak of the existence of an organism thus related to the cerebrum yet not evident to our senses. Yet the more we consider the brain as the organ of mind the less does it seem adapted to the duties thus imputed to it. It has of late

been rendered almost certain, by the researches of Ferrier and others, that each region of the cerebrum has its special duties, to the performance of which it is strictly confined. Here sensation seems to center; there motor impulses arise. Into this locality flow the sensations of sight; into that locality those of taste or smell. Speech has its center here; the motion of a particular muscle there. Instead of the whole brain being concerned in every action, each limited portion seems to be immediately and strictly related to some fixed sensory or motor region. The evidences of this are as yet somewhat broad and general, yet they are steadily growing more precise and particular. Every nerve fiber proceeding from a sensory end organ or a group of muscle fibers may connect directly with a special group of brain cells, and possibly every fibril of these fibers may terminate in a single brain cell at one extremity, and in a single muscular fibril or sensory point at the other. If such were the case the brain would be closely related in condition with the outer terminations of the nerves, and the nervous system would consist of a vast series of fibers diverging outwardly to terminate in a widely separated series of sensory and muscular cells and fibrils, and converging inwardly to terminate in a closely aggregated series of nerve cells, the latter being as individual in their duties as the former, despite their much closer grouping.

This, of course, is purely hypothetical, yet the special relation of groups of brain cells to groups of sensory or muscle cells or fibers has been established by experiment, and it is not safe to limit the possible minuteness of this relation. Yet the existence of such a relation seems to stamp the brain as the instrument of an interior mental organism. In the operations of the mind there is no evidence of such a disconnected series of duties. The mind constantly impresses us as an intimate unity. Its thoughts are in continual rapport, and call up each other with instantaneous rapidity. Such a relation could not well exist between the imagined localized vibratory energies of the brain. If each locality were capable of sending its vibrations at will to any other locality, and rousing into activity the energies of distant regions, what is to hinder the complete dissemination of these energies? If such a condition existed, the fibrils of every cell in the brain must soon become affected with a vast multitude of diverse and frequently discordant pulsations. And it is impossible to imagine

how such pulsations, even if their continued local existence were possible, are to be thus restrained and confined. They are capable at intervals of flowing out upon the fibers of the motor nerves. What hinders them from immediately flowing out? By what power are they retained, so as to be let off at arbitrary and far separated intervals? And when once such vibratory energies are set free upon the motor nerves how can they still exist in the brain? Thought is persistent, yet on this theory it could only be persistent if it never produced any effect. Motion cannot be increased or diminished at will. It cannot be discharged and yet retained. It cannot become an outflowing radiation while still existing with undiminished vigor as an organizing agent.

The problem of consciousness comes into the question here. If thought be a persistent motor affection of the nerve fibrils, and if consciousness is an accompaniment of all active thought, why then are we not steadily conscious of all our thoughts? Are we to look upon consciousness as a separate traveling agency, which moves irregularly from part to part of the brain, and adds a new increment of activity to every thought with which it momentarily combines? We can in no other way explain the vagaries of consciousness on the brain-mind hypothesis.

Again, if the brain is the organ of the mind, one of two things must be true. Either every brain cell must contain a special portion of the mental energies, or, if the thought vibrations can make their way everywhere through the brain, every cell must be a miniature copy of the whole mind. The localization of the powers of the brain is an argument for the former. The close interrelation of thought seems to necessitate the latter. The dilemma of the brain-mind theorists has its two horns of difficulty, and it becomes incumbent upon them to harmonize these opposed conditions. Another difficulty connects itself with the preceding. This is, that the cerebral cells are not permanently in existence. Every action is attended by cell waste. The old cells die and new ones take their place. Or new ones arise by the process of cell division. If the cells are reservoirs of special motor forces, what becomes of these? Are they transmitted hereditarily to the new cells? This can hardly be, since the death of the old cell is often a consequence of the transmission of its special energy to motor nerves. It cannot, therefore, transmit more than its general organizing energy to new cells. The

germ cell of an animal exists as a remarkable counterpart of the general energies of its parent, and the offspring develops into a close copy of the parental physical characteristics and mental conditions. Yet the special knowledge of the parent is never transmitted to the child. Unless the latter gain special knowledge of its own, it will remain in this respect undeveloped. So one cell may transmit to its successor its organizing characteristics, but scarcely its more delicate special motor conditions.

In fact, the more we consider this hypothesis the more unsatisfactory does it appear. If the brain is to be looked upon as a material organism, a machine with thought for one of its products, we might naturally expect to find some analogy to its mode of action in other machines. It is credited with a double duty. It is a receiver and dispatcher of nervous impressions, and it has a special discriminating power as to how, when and whither it shall despatch these impressions. What is there in the brain to decide which impressions shall be retained and which transmitted? Are there special resistances in some cells of the brain which hinder the transmission of sensory impressions to the muscles? If so, how come these resistances to break down at such arbitrary periods. What principle makes some cells resisting and others non-resisting? How is it, again, after this resistance has yielded, and the motor energy flowed out to the muscles, that the thought which it represents is still found intact in the mind, and usually stronger than before? What machine is it that has its energy within itself and still possesses it after using it to set a train of wheels in motion? And finally, how do we explain the peculiar relations of consciousness to these thought impressions?

All this presents no difficulty if we can conceive of a mental organism distinct from, but in the most intimate relation with, the cerebrum, upon whose separate regions its thoughts play, like the fingers of a performer upon the separate keys of a piano. The same finger may touch many keys in succession and bring out a special tone from each. The player may be a single organism, a resultant of organizing motor energies inherent in a definite mass of substance, while the instrument may be made up of many separate parts, having only general and no intimate interrelations. The player may bring out what sound he desires, but it would not be easy for one key to emit another sound at will, or to force another key to emit its special sound. And even if the piano

key had a reservoir of energy by which, at some arbitrary period, it could suddenly spring into activity and yield a peculiar sound, evidently a part or the whole of this special force must be exhausted in doing so. But if struck by an exterior organism the latter might be strengthened by the exercise, as a muscle is strengthened by use. This is a characteristic feature of mental action. Its special energies, or its thoughts, are strengthened by use. It seems evident that such a condition can only exist in the case of a definitely centralized organism, affected by motion as an organizing agent, and also by generalized motions, which it has the power to divert in certain directions without detriment to its organization. Such is the human body. It is definitely organized by the double agency of chemical affinity and inhering motions, which limit the condensing action of affinity. In addition it is the seat of heat, electric and other motions, which it can employ as agents of external action. The mind, as an organism, displays these same characteristics. It is organized by permanent motor conditions. It receives and emits definitely directed motions. And its organization is affected and developed through this activity precisely as the organization of the body is aided and modified by the energies which it receives and emits. The parallel is a close one, and indicates that the mind, like every organism in nature, is a self-centered mass of substance, held together by affinity and organized by inherent motions.

There is nothing in the conditions of the cerebral organ to indicate that it is such a single, definite organism, or that it is capable of manifesting the peculiar phenomena of the mind. The great difficulty in the brain-mind theory is that the machine cannot contain within itself the voluntary will power of the engineer. If thoughts are the motor energies of the brain matter it is simply incredible that they could arbitrarily retire from and reënter the field of activity. The character of their activity must be fixed, constant and unvarying. And the effects they are capable of producing must be immediately or incessantly produced. It is impossible to conceive of a self-acting machine under any other relations. All its energies must be steadily in activity, and its effects on outer matter must be limited and constantly similar. We cannot imagine such a machine arbitrarily changing its action; now producing one effect, now another; now acting on

one substance, now on another; its different parts irregularly rising into activity or sinking into quiescence; and its energies continuing unchanged and inexhausted through all this varied outflow of motor activity. No instance of the kind was ever seen or can be imagined to exist. The existence of such arbitrary and seemingly voluntary activity irresistibly leads to the inference of a separate agent overruling the action of the machine, and now calling this, now that part into activity. On the theory of self-action of any instrument it is impossible to admit the existence of arbitrary and irregular variations of activity like those of the mind. On the opposite theory that the mind is an organism separate from the brain, and using the latter as its instrument, we can readily comprehend the varying action of the instrument. If the two be in close but not in constant connection; if the mind now makes contact with one group of brain cells, now with another, and now withdraws from all contact, the difficulty diminishes. Why these varying contacts takes place is a question of a different character. They may be due to influences of affinity or polarization, which are subject to change under the changes in cerebral conditions which they induce. Or they may be otherwise produced. It is difficult to understand the cause of such seemingly arbitrary contacts; but this difficulty is not an impossibility like that attending the brain-mind theory. And under the idea that the mind is a separate organism we can understand the vagaries of consciousness, which cannot possibly be done under the brain-mind hypothesis. This subject will be considered later.

There is one more consideration to which we may briefly advert. The cerebrum is subject to pathological changes. It frequently becomes incapable of doing its duty properly. In many instances of cerebral disorder the mind seems to disappear. A whole series of mental conditions may utterly vanish, and remain lost for years. A new series of mental conditions may be built up. Or every trace of intelligence and consciousness may disappear and the body act as a mere automaton, governed by reflex action only, or possibly by the deeply based hereditary or instinctive mental powers. And yet, after years of this mental obliteration, there are instances on record where the brain recovered its normal condition and the mind reappeared with all its former contents of memories, opinions and ideas. Such a cir-

cumstance it is impossible to comprehend under the theory that the thoughts are but motor affections of brain matter. In these years of disorder it is absolutely certain that considerable modifications must take place in this matter. The motions affecting its cells and fibers cannot continue absolutely the same as they were years before, but must have become greatly changed and reorganized under years of influx of external energies. But if we view the mental organism as separate from the cerebrum these strange phenomena lose much of their mysteriousness. In that case the disorder of the cerebrum may not have directly affected the mind, but simply broken the connection between the mind and its organ of manifestation and development. The mental organism may lie for years intact, as a crystal lies buried in its bed of rock. It retains its original conditions since it has been removed from the influence of disturbing energies. And when once again it regains its powers of manifestation, through the regained normal condition of the cerebrum, it must reappear in the precise condition which it had attained at the period of the broken connection, and with all its memories and ideas intact.

If we consider the relations of the nervous system from this point of view, we perceive it to be composed of a vast aggregate of fibers, which divide into their constituent fibrillæ in the ganglion cells. These fibers are in contact, at their opposite extremities, with two distinct sources of energy. One series of them runs from the brain to the sense organs on the surface. Another series runs from the brain to the muscles. The first series has its receptive extremities at the surface, and conveys the energies of external nature to the brain to discharge them into the mental organism. The second series has its receptive extremities in the brain, and conveys energies received from the mental organism to the muscles, there to discharge them. Each of these fibers apparently has its fixed and single duty. If one of the sensory nerves be touched, it carries an impression to a fixed locality in the brain. If one of the motor nerves be touched, it carries an impression to a fixed muscle. The more deeply anatomy and physiology search into the conditions of the nervous system the more clearly it appears to be simply such an instrument for the conveyance of impressions to and from two sources of energy, an external and an internal one, and the less fitted does it seem to sustain the theory that the brain is the organ of the mind.